

**DEEPWATER SHELLFISH AQUACULTURE —
AN ECONOMIC PROFILE**

Prepared for:

**Economic Development Branch
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BUILDING BLOCKS FOR ECONOMIC DEVELOPMENT & ANALYSIS

PREFACE

PURPOSE

Building Blocks have been conceived and developed by the Economic Development Branch of the Ministry of Sustainable Resource Management, under the guidance of Nancy South, Manager Economic Analysis, as an analytical tool that supports British Columbia coastal and land and resource use planning and decision-making and economic development initiatives. The Blocks contain concise business and sector information for a broad range of resource-based business types in BC. At this point, there are more than 30 Blocks either complete or in draft form. Several more Blocks have been identified as high priority by planning tables and other client groups. Additional Building Blocks will be developed over time, and some Blocks may be updated. For the most current Building Blocks, please see the Ministry of Sustainable Resource Management website, at: <http://srmwww.gov.bc.ca/rmd/ecdev/>

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BENEFITS

Building Blocks are expected to provide the following general benefits:

- Increase efficiency and more informed decision-making by providing readily accessible, credible information to planning and economic development processes;
- Improve the consistency of economic information across planning areas;
- Support economic analysis and decision-making that occurs outside formal coastal and land use planning processes; and
- Provide linkages between economic analysis and other social and environmental analytical tools (through identifying resource requirements to support economic activities and general compatibilities with other sectors and values).

LIMITATIONS

Every effort has been made to ensure that the information contained in Building Blocks is accurate and consistent. Approved, credible data sources are the foundation for Building Blocks. All Blocks were reviewed by sponsoring agencies and other experts. However, users are cautioned that information is used at their own risk, and that the authors and sponsors are not liable for any damages. Any conclusions or interpretations by the authors are not intended to represent government policy. Also, note that Building Blocks do not provide site specific information nor do they consider requirements for sustainability (social, community, environmental).

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1.0 OVERVIEW OF BUSINESS OPPORTUNITY

1.1 Description

Farming shellfish (bivalve molluscs) in protected coastal waters outside of intertidal areas at depths of between 10 and 30 meters using flotation systems.¹

1.2 Planning Areas where Business May be Developed

Vancouver Island, Central Coast, North Coast, Queen Charlotte Islands – Haida Gwaii.

1.3 Key Products

- Pacific Oyster (*Crassostrea gigas*) – single oysters for the fresh/quick frozen half shell market, or oysters by the gallon for the fresh/frozen and canned shucked markets.
- Blue and Mediterranean Mussels (*Mytilus edulis* and *Mytilus galloprovincialis*) – mussels for the fresh in shell or shucked markets.
- Japanese Scallop (*Patinopecten yessoensis*) – scallops for the fresh in shell or shucked markets.

1.4 Marketing

Fresh product is sold directly to processing plants where it is prepared for shipping and distribution to markets. The majority of this processed product is exported.

Opportunities also exist for independent farmers to work cooperatively and pool their fresh product prior to selling it to a processing plant. This has the potential to increase their visibility, save on shipping costs, offer better continuity of supply and attract a better price for the product.

1.5 Production

There are four basic steps involved in deepwater shellfish farming: (1) accessing seed, (2) rearing the seeds in a nursery, (3) transferring the seed to deep water for grow-out, and (4) harvesting.

There are many different options for farming these shellfish species, with each option requiring different resources and inputs. In B.C. culture techniques are most developed for oysters. Farming single oysters typically uses trays suspended from rafts or longlines, while farming shucked product is done on shell cultch or tubes suspended from rafts or longlines. The B.C. Shellfish Growers Information Resource System www.bcsга.ca/bcsgirs provides an overview of the range of possible production methods for deepwater farming of oysters, scallops and mussels.

1.6 Selecting a Farm Site

Key criteria for selecting farm sites include: areas of coastal water that are biophysically capable of growing shellfish (see section on Resource Requirements and Sensitivities), are relatively protected and not deeper than 35-40 meters (to enable safe and affordable anchoring of the farm), and offer affordable access to transportation infrastructure, labour and registered shellfish processing facilities (see section on Key Infrastructure Requirements).

1.7 Associated Businesses Providing Direct Inputs into the Business

- Seed producers – Seed for scallop and mussel culture is readily available from B.C. businesses; oyster seed is also available from B.C. businesses but is often sourced from businesses in Washington State.
- Marine and hardware suppliers – All inputs required to build and operate deepwater farms are readily available from B.C. businesses.

2.0 OVERVIEW OF EXISTING DEEPWATER SHELLFISH AQUACULTURE INDUSTRY

2.1 Size and Location of Industry²

The shellfish aquaculture industry in 2002 comprised over 200 companies operating farms on 485 shellfish aquaculture tenures and 2,504 hectares of Provincial Crown Land. Over 85 per cent of the farm production takes place on the East Coast of Vancouver Island.

It is difficult to precisely identify the portion of the current industry activity that is done in deepwater because some tenures include both intertidal and deepwater areas. The total area currently under tenure for deepwater shellfish aquaculture is estimated to be between 700 and 900 hectares.

2.2 Value and Volume of Production³

Deepwater shellfish aquaculture production in B.C. is growing in volume and value. Total production of oysters, scallops and mussels in 2001 (including some oyster production from intertidal areas) was approximately 6,900 tonnes and generated some \$7.2 million in farm gate sales. This represented an increase of approximately 24 per cent over production and sales results realised in 1999.

Oysters are the primary product currently being produced, with single oysters the most popular product form. In 2001 total farm gate sales for oysters (includes some production from intertidal areas) was \$7.1 million of which 70 per cent were single oysters.

3.0 RESOURCE REQUIREMENTS AND SENSITIVITIES

3.1 Provincial Crown Resources Required to Support Business

Provincial Crown Land – primarily coastal waters for farms, but also land for associated support activities.

3.2 Resource Capability

The provincial government has completed an assessment of the extent of coastal B.C. waters biophysically capable to support the growing of Pacific Oysters and Japanese Scallops. The assessment is based on 14 environmental variables including summer and winter water temperatures and salinity. The results suggest there are ample areas of coastal water capable of supporting farm expansion. For example, there is an estimated 6,500 hectares of Crown land outside of protected areas on the west coast of Vancouver Island alone capable of supporting deepwater shellfish aquaculture – roughly 7 to 9 times the area currently under deepwater shellfish tenure.⁴

The capability of marine waters to grow shellfish that are safe to consume (i.e. not contaminated) is also dependent on water quality. Environment Canada is responsible for surveying and classifying water quality throughout coastal areas of the province. Approximately 75 per cent of southern B.C. was classified “approved” for shellfish growing in 2002; limited water quality surveys, however, have been completed for northern coastal waters of the province. Water quality classifications change based on monitoring and re-evaluation surveys. Shellfish growing can be permitted in contaminated areas under special licence from the Department of Fisheries and Oceans if the product is cleansed (depurated) before being sold.⁵

3.3 Potential Complementary/Conflicting Relationships with other Resource Values

Environmental Values⁶

There is potential for farms to (a) disturb/harm wildlife, particularly birds, through noise and human activity, and (b) modify habitat and alter the composition of benthic communities underneath growing areas as a result of the accumulation of organic sediments. Most effects are either considered of low to moderate severity, or able to be mitigated through sensitive and diligent management.

Farms also have the potential to (a) improve water quality (by reducing turbidity) and sediment productivity (by recycling nutrients), as well as (b) provide structural habitat for suspension feeders such as tubeworms and shrimp, which in turn are important food sources for grazing fish and birds.

Other Values

Farms can pose potential conflicts with a range of other resource users including: local residents (visual quality and noise); tourism operators and recreationalists (visual quality and interfering with water travel routes); commercial underwater harvesters (limiting access to desired harvesting areas), commercial fishers (interfering with spawning areas and limiting fishing access), and forestry operations (limiting access to desired areas for log dumps and interfering with water travel routes).⁷

4.0 REGULATORY REGIME

4.1 Tenures, Licences and Other Approvals Required for a New Farm⁸

All deepwater shellfish projects require the following approvals in order to commence operations:

- Provincial Crown Land tenure issued by Land and Water British Columbia Inc.;
- Provincial Shellfish Aquaculture Licence issued by the Ministry of Agriculture, Food and Fisheries;
- Approval under the *Navigable Waters Protection Act* issued by the Canadian Coast Guard;
- Approval under the *Fisheries Act* issued by the Department of Fisheries and Oceans.

Two types of Crown Land tenure can be issued for shellfish operations:

- Lease – in cases where substantial improvements are proposed (maximum term 30 years);
- Licence – in cases where minimal improvements are proposed (maximum term 20 years).

New Shellfish Aquaculture Licences are issued for a term of 1 year.

4.2 Process of Securing Approvals

All applicants must complete a shellfish application package and submit it to the Shellfish Management Office, Land and Water British Columbia Inc. located in Nanaimo. The package should include information stipulated by provincial authorities (application for a Crown land tenure, application for a commercial aquaculture licence, shellfish management plan, and an economic impact questionnaire), as well as Federal authorities (information requested in the *Navigable Waters Protection Act* application guide for aquaculture projects in British Columbia, and information requested by the *Canadian Environmental Assessment Act* (CEAA) screening process for aquaculture projects).⁹

4.3 Approximate Time and Cost to Gain Approvals

Preparing a complete application package is a time consuming process, and depends on a number of factors including location of the site. If done by a specialised consultant, this could take 15 to 20 working days. It can take considerably longer when prepared by an inexperienced applicant.¹⁰

The minimum amount of time it takes to secure the four required approvals is 4.5 months from the date the application package is accepted by Land and Water British Columbia Inc. as being complete. It is common for the process to take longer, especially if government agencies are forced to contact the applicant requesting clarification or additional information.¹¹

The cost for the Provincial Crown Land tenure approval is \$5,000 (\$500 paid on submission of the application and \$4,500 on final approval). An annual rent is also charged and varies according to the size, type and land value of the tenure. Rent during the first four years of a new tenure is calculated at 1 per cent of the tenure's estimated value, and then increases to 4-5 per cent.¹²

The annual cost of a Provincial Shellfish Aquaculture Licence is \$50.¹³

There are no fees charged for the *Navigable Waters Act* and *Fisheries Act* approvals.¹⁴

4.4 Availability of New Crown Land for Shellfish Aquaculture¹⁵

The provincial government committed in 1998 to doubling the amount of Crown land allocated to shellfish aquaculture (beach and deep water) by the year 2008. This amounted to an increase of approximately 2,350 hectares over a 10-year period. After 4 years the total land area allocated to shellfish has increased by a total of 150 hectares.

Land and Water British Columbia Inc. is in the process of signing Memorandums of Understanding with First Nations to set aside Crown land that can be used by First Nations for shellfish aquaculture. As of July 2002 a total of 544 hectares (beach and deepwater) of Crown land had been allocated to First Nations under this process.

As of July 2002, the general process to allocate new shellfish aquaculture tenure was under review by Land and Water British Columbia Inc., and no new areas of Crown land were officially "open" for tenure application. New tenure applications, however, were still being accepted on an ad hoc basis.

5.0 INVESTMENT REQUIREMENTS

5.1 Start-up and Ongoing Costs for Deepwater Shellfish Farm Operations¹⁶

Investment requirements depend on a variety of factors including type of production and technology used, as well as farm size. Profitability of an operation similarly depends on many variables including product survival rate, selling price, cost of getting product to market, and cost and availability of labour. The following examples are for possible oyster and scallop farms located on the east or west coast of Vancouver Island approximately 30 km from dock to site round trip. Estimates of initial capital investment requirements are for farm infrastructure, including a work boat, and exclude growing stock. Seed costs are included as a component of ongoing operating cost estimates. All production is sold directly to a processing plant where it is prepared for shipping and distribution to markets.

Building Blocks for Economic Analysis

Product: 100% Single Oysters for half shell market

- Production technique – raft/tray
- Total farm size – 2.0 hectares
- Annual product survival rate – 80 per cent
- Time required to grow product – 11 to 14 months
- Initial capital investment – \$100,000
- Ongoing operating costs (excluding financing costs) – \$105,000 per year
- Expected annual product sales – \$150,000 (806,400 oysters @ \$0.185/oyster)
- Approximate time required to recoup initial investment – 5 to 6 years

Product: 100% Shucked Oysters

- Production technique – longline
- Total farm size – 6.0 hectares
- Annual product survival rate – 80 per cent
- Time required to grow product – 21 to 24 months
- Initial capital investment – \$130,000
- Ongoing operating costs (excluding financing costs) – \$130,000 per year
- Expected annual product sales – \$300,000 (1,993,600 oysters @ \$0.15/oyster)
- Approximate time required to recoup initial investment – 5 years

Product: Scallops (50% fresh in shell, 40% shucked and 10% fresh “roe-on” meat)

- Production technique – longline/pearl net
- Total farm size – 16.2 hectares
- Annual product survival rate – 50 per cent
- Time required to grow product – 25 to 32 months
- Initial capital investment – \$300,000
- Ongoing operating costs (excluding financing costs) – \$145,000
- Expected annual product sales – \$225,000 (249,975 scallops @ \$0.90/scallop)
- Approximate time required to recoup initial investment – 10 years

6.0 KEY INFRASTRUCTURE REQUIREMENTS

6.1 Access to Transportation Infrastructure

Road, ferry, and in the case of more isolated locations, coastal shipping services are necessary in order to construct and operate farms, as well as transport farm products to processing facilities. The more isolated the farm site, the less flexibility an operator has in accessing farm inputs and shipping farm products, and the higher the per unit operating costs.

6.2 Access to Labour

Access to labour is necessary in order to operate farms. In general, the more isolated a farm, i.e. lack of people living in the immediate area, the more expensive labour costs will be.

6.3 Access to Processing Facilities

All commercial shellfish grown in B.C. (for local consumption or export) must be processed at a facility that is registered by the Canadian Food Inspection Agency. Processing capacity is in general not a constraint to new industry development. Farms developed on the west coast of Vancouver Island and in the central and north coast, however, may face more difficulties in this regard than those located on the east coast of Vancouver Island. As of July 2002, for example, there were no registered shellfish processing facilities in Prince Rupert. Farms establishing in this area would either need to transport their product south to existing processing facilities, or encourage local fish processing facilities to expand the range of products they can handle to include shellfish.¹⁷

7.0 MARKET

7.1 Global Demand for Seafood and Shellfish Products¹⁸

Global demand for seafood is increasing. Since the mid-1990s the wild fisheries catch has reached a plateau. Aquaculture is regarded as the most important means to address this gap.

Global aquaculture expanded at a rate of more than 10 per cent per year during the 1990s. Mariculture comprises one third of global seafood farming by weight and the cultivation of marine finfish and shellfish has been the fastest growing segment within aquaculture sector.

Farmed bivalve mollusc production volumes are fairly evenly split between oysters, clams, mussels and scallops. International trade in shellfish is relatively limited with less than 10 per cent of the total output traded. International trade statistics often do not distinguish whether shellfish was of wild or farmed origin. Of the shellfish output that is traded, approximately 70 per cent of the value is concentrated in scallops and clams (fresh and frozen). In 1995, the most current year for which global statistics were available, scallop imports were valued at \$670 million, clam imports at \$400 million, mussel imports at \$255 million and oyster imports at \$190 million. The major importing countries were Japan, U.S. and France, while the major exporters were China and the Republic of Korea.

7.2 Primary Markets for B.C. Shellfish Products¹⁹

The U.S. (particularly the western region) has been, and is expected to continue to be, the major market for B.C. shellfish products. This is because of its market size, strong demand for fresh seafood products, relatively free trade access, and proximity (transportation cost advantages over competing exporting countries). The population in this region is among the fastest growing in the U.S. and includes large urban areas of affluent, sophisticated consumers with a concern for nutrition, health foods and quality of life. Demand is increasing for high quality, safe shellfish products from known "clean" growing areas. For example, over the period 1995 to 2001 the value of farmed oyster exports from registered processing facilities in Canada to the U.S. increased by 98 per cent, while the quantity shipped increased by 56 per cent.²⁰

B.C. and Alberta are also important markets for B.C. shellfish products, and apart from population size, display similar trends and characteristics to the U.S. market.

South East Asia (particularly Hong Kong and Taiwan) and the European Union are other potential markets for B.C. shellfish that to date have not been developed to the extent of those in the U.S. and Canada.

7.3 Factors Affecting Exports²¹

Most countries targeted for export sales are gradually reducing trade barriers for Canadian products. Importing country regulations for bivalve molluscs, however, are stringent in most cases.

Maintaining strict controls over B.C. inspection procedures at processing facilities and ensuring high quality products are essential to encourage on-going removal of trade barriers for Canadian products.

There is also an increasing trend in many markets to require the tracking of product safety and quality back to the original producer. The global standard for doing this is HACCP (Hazard Analysis Critical Control Point). At the moment shellfish farm operations are not legally required to have such a system in place – it only applies to processing facilities. The Canadian Food Inspection Agency is undertaking a project to encourage the voluntary implementation of HACCP by shellfish farms.

8.0 LABOUR MARKET

8.1 Skill Requirements²²

An operating farm typically requires a manager and one or more farm hands.

All workers should be comfortable working outdoors and on the water, and be physically fit since the work is at times strenuous. They should be willing to work long hours on a range of tasks, often without supervision. They should also be good at working with their hands in order to set and sort seed, as well as use, maintain, repair tools and equipment. First aid and diving certification would be beneficial.

The farm manager should also possess small business skills (i.e. planning, management, sales, book-keeping and administration), along with a technical understanding of shellfish husbandry.

8.2 Seasonality/Intensity of Work

Much of the work is seasonal and takes place during periods of seed stocking/sorting and harvesting. An ongoing presence is also required to ensure the smooth operation of the farm.

8.3 Wage Rates

Farm worker wage rates range between \$10 and \$20 per hour and depend on skill requirements and level of responsibility.

8.4 Employment Generated

Farm labour requirements depend on the size of the operation and type of production used. Annual employment per hectare is estimated to be between 0.12 and 1.00 FTEs (person working 225 days a year). During peak periods such as stocking and harvesting there could be 3 to 4 people working on a farm.²³

The employment multiplier for shellfish farming was estimated in 1998 to be 1.65, i.e. a farm that had annual employment of 1.0 FTE would generate an additional 0.65 FTEs of employment through its purchase of goods and supplies from suppliers (indirect effect), and respending of incomes earned directly and indirectly (induced effect).²⁴

9.0 GOVERNMENT REVENUES

9.1 Key Sources of Government Revenue

Rent on Crown land tenure – \$5,000 to secure a new tenure, plus an annual rent of approximately \$250 per hectare (actual rent will vary depending on the assessed value of the land).

Other key sources of revenue include: tax on employee earnings; sales tax on business inputs; and, tax on business profits.

10.0 SUMMARY

10.1 Description of the Existing Deepwater Shellfish Industry

The following table summarizes available information about the existing deepwater shellfish industry in B.C.

Existing Deepwater Shellfish Industry, 2001/02²⁵

Indicator	Description	Coefficient (per hectare of Crown Land)
Total area of crown land under tenure	700 – 900 hectares	
Primary products produced	Oysters, Scallops and Mussels	
Total quantity of products produced*	6.9 tonnes	
Total sales value of products produced*	\$7.2 million	\$8,000 – \$10,285 per hectare
% breakdown of sales by product	oysters 98% scallops/mussels 2%	

* Also includes some product that was produced in intertidal areas.

10.2 Expected Economic Effects From New Deepwater Shellfish Farms

The economic inputs into, and outputs from, new deepwater shellfish farms will vary considerably farm to farm. Key determining factors include: farm location and size, type of product focused on, production technique used, and the business and husbandry skills of the operator. The following table provides coefficient per productive hectare of Crown Land for possible oyster and scallop farms located on Vancouver Island and may not be representative of operations located in more remote locations. Note, the coefficients are estimates and are intended to provide an appreciation for their relative order of magnitude.

**Estimated Coefficients per Hectare Crown Land for
New Deepwater Shellfish Farms²⁶**

Indicator	Oysters		Scallops
	Single/Half-Shell Market	Shucked Market	Mixed Products
Farm size	2.0 hectares	6.0 hectares	16.2 hectares
Initial Investment	\$50,000/hectare	\$22,000/hectare	\$18,500/hectare
Annual Sales**	\$75,000/hectare	\$50,000/hectare	\$14,000/hectare
Direct Employment	1.00 FTEs/hectare	0.33 FTEs/hectare	0.12 FTEs/hectare
Rent on Crown Tenure	\$250/hectare	\$250/hectare	\$250/hectare

** These coefficients are greater than the Industry average sales coefficient for several reasons. First, they assume efficient and full productive use of the resource. The industry average likely includes less efficient operators, and may include areas that did not produce during that year. Second, the coefficients represent areas used only for cultivation. The existing industry likely includes tenures where only a portion of the area is used for cultivation. Significant areas, for example, may be taken up by the anchoring system or by boat navigation corridors among culture apparatus.

SOURCES OF INFORMATION

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- ¹ A separate report is being done for beach shellfish aquaculture, i.e. farming of bivalve shellfish in intertidal areas.
- ² Personal communication, Barron Carswell, Ministry of Agriculture, Food and Fisheries, Victoria.
- ³ *The 2001 British Columbia Seafood Industry in Review* (draft), Ministry of Agriculture, Food and Fisheries.
- ⁴ *The Economic Potential of the British Columbia Marine Aquaculture Industry*, 1998, Coopers and Lybrand Consulting.
- ⁵ The Shellfish Water Quality Protection Program on the West Coast of Canada, information available at the Environment Canada website www.pyr.ec.gc.ca/ep/shellfish/shell_e.htm, and personal communication, Walter Hajen, Environment Canada, Vancouver.
- ⁶ *Activities and Potential Environmental Effects Associated with Shellfish Aquaculture in Baynes Sound: A Discussion Document*, March 2002, Brian Emmett, Archipelago Marine Research Ltd.
- ⁷ *Draft Baynes Sound Shellfish Aquaculture Action Plan*, March 2002, Ministry of Sustainable Resource Management, Resource Management Division.
- ⁸ Various documents available at the Land and Water British Columbia Inc. website www.bc-land-assets.com/for_business/shellfish, and personal communication, Tom Hilborn, Land and Water British Columbia Inc., Nanaimo.
- ⁹ Personal communication, Tom Hilborn, Land and Water British Columbia Inc., Nanaimo and Paula Doucette, Department of Fisheries Oceans, Vancouver.
- ¹⁰ Personal communication, Ian Sutherland, IEC, Victoria.
- ¹¹ Personal communication, Tom Hilborn, Land and Water British Columbia Inc., Nanaimo.
- ¹² Various documents available at the Land and Water British Columbia Inc. website www.bc-land-assets.com/for_business/shellfish.
- ¹³ Personal communication, staff, Ministry of Agriculture, Food and Fisheries, Regional Office, Courtenay.
- ¹⁴ Personal communication, Jennifer Nener, Department of Fisheries and Oceans, Vancouver.
- ¹⁵ Personal communication, Barron Carswell, Ministry of Agriculture, Food and Fisheries, Victoria and Tom Hilborn, Land and Water British Columbia Inc., Nanaimo.
- ¹⁶ Personal communication, Bill Heath, Ministry of Agriculture, Food and Fisheries (MAFF), Courtenay along with Investment, Cost and Return profiles prepared for selected shellfish species by MAFF.
- ¹⁷ Personal communication, Gord Craig, Canadian Food Inspection Agency, Vancouver.
- ¹⁸ *State of World Fisheries and Aquaculture*, 1998, Food and Agriculture Organisation (available at www.fao.org), and *Marine Aquaculture in the United States*, 2001, Rebecca Goldberg, Mathew Elliott and Rosamund Naylor, prepared for the Pew Oceans Commission (available at www.pewoceans.org).
- ¹⁹ *Market Competitiveness Analysis of the B.C. Shellfish Industry*, 1996, Renwick & Associates, prepared for the B.C. Shellfish Growers Association.
- ²⁰ National Marine Fisheries Service, Fisheries Statistics and Economic Division website www.st.nmfs.gov.

²¹ *Market Competitiveness Analysis of the B.C. Shellfish Industry*, 1996, Renwick & Associates, prepared for the B.C. Shellfish Growers Association, and Personal communication, Gord Craig, Canadian Food Inspection Agency, Vancouver.

²² Aquaculture & Marine Harvest Labourer information available at Cowichan Labour Market Information website www.cowichan.org.

²³ Personal communication, Bill Heath, Ministry of Agriculture, Food and Fisheries, Courtenay.

²⁴ *The Economic Potential of the British Columbia Marine Aquaculture Industry*, 1998, Coopers and Lybrand Consulting.

²⁵ Personal communication, Barron Carswell, Ministry of Agriculture, Food and Fisheries, Victoria and *The 2001 British Columbia Seafood Industry in Review* (draft), Ministry of Agriculture, Food and Fisheries.

²⁶ Personal communication, Bill Heath, Ministry of Agriculture, Food and Fisheries (MAFF), Courtenay along with Investment, Cost and Return profiles prepared for selected shellfish species by MAFF.